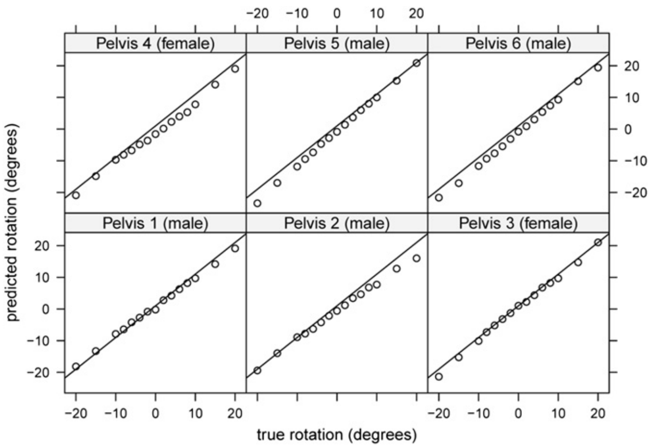

Figure 3. Predicted versus true rotation for the 6 pelvises under study.

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RELATIONSHIP BETWEEN SHAFT BOWING IN THE FEMUR AND TIBIA AND BONE MINERAL DENSITY IN WOMEN WITH VARUS KNEE OSTEOARTHRITIS

Y. Akamatsu [1], N. Mitsugi [2], H. Kobayashi [2], K. Kumagai [1], Y. Kusayama [1], T. Saito [1]. [1] *Yokohama City Univ. Sch. of Med., Yokohama, Japan;* [2] *Yokohama City Univ. Med. Ctr., Yokohama, Japan*

Purpose: Anterior and lateral shaft bowing of the femur and tibia in patients with varus knee osteoarthritis (OA) results in malalignment of the whole lower extremity, when the preoperative planning in total knee arthroplasty or high tibial osteotomy is performed on the knee radiograph. Previous studies reported that femoral shaft bowing in women was different from that in men. To our knowledge, no studies investigating the relationship between shaft bowing in the femur and tibia and bone mineral density (BMD) have been reported. We hypothesized that anterior and lateral shaft bowing in the femur and tibia was related with age, body mass index (BMI), and BMD in women with varus knee OA. The main aim of our study was to assess the relationship between anterior and lateral shaft bowing in the femur and tibia and BMD in women with varus knee OA.

Methods: We enrolled 52 women between April 2010 and March 2011 at our institution. All patients had symptomatic primary varus knee OA. Anteroposterior and lateral whole leg radiographs were taken with the patients in a standing position. Femoral and tibial shaft was divided into five equal parts. In the coronal and sagittal planes, anterior and lateral shaft bowing of the femur and tibia were defined as the angulations between midlines drawn in the second and forth parts from the proximal femur and tibia. The Kellgren and Lawrence grades were grade 2 in 3 knees, grade 3 in 7 knees, and grade 4 in 42 knees. Limb alignment was expressed as the femorotibial angle (FTA) obtained from the anteroposterior radiograph. BMD values were measured in L2-L4 vertebrae and the femoral neck using a QDR-4500 (Hologic Inc., Bedford, MA, USA). The lumbar spine and femoral neck BMDs were analyzed using standard software. BMI was calculated as an index of obesity. Data are expressed as means and standard deviation. Significance was set at $p < 0.05$. We used Pearson's correlation coefficients to investigate the relationship between two continuous variables (bowing, age, BMI, and BMDs).

Results: Mean age and BMI were 72.4 ± 8.9 years and 26.6 ± 4.4 kg/m^2, respectively. Mean FTA was 183.6 ± 3.4 degree. Anterior femoral shaft bowing was positively correlated with age and negatively correlated with femoral neck BMD ($r = 0.317$, $p = 0.022$, and $r = -0.345$, $p = 0.012$, respectively). Lateral femoral shaft bowing was not related with multivariate factors. Anterior tibial shaft bowing demonstrated a positive correlation with BMI ($r = 0.283$, $p = 0.042$). Lateral tibial shaft bowing was positively correlated with age and negatively correlated with femoral neck BMD ($r = 0.364$, $p = 0.008$, and $r = -0.293$, $p = 0.035$, respectively).

Conclusions: Karakas and Harma stated that anterior femoral shaft bowing was related with age. Our results showed that anterior femoral shaft bowing was correlated with age and femoral neck BMD. Contrary to our expectation, lateral femoral shaft bowing was not related with femoral neck BMD. Only anterior tibial shaft bowing was affected by BMI. Also, the relationship between anterior tibial shaft bowing and lumbar spine BMD might be associated with degenerative changes of the lumbar spine. Lateral tibial shaft bowing was correlated with age and femoral neck BMD, although anterior tibial shaft bowing was not related with femoral neck BMD. In Japanese, these results in the tibia might be associated with congenital tibia vara. The results from our small number of patients should be considered preliminary. However, if shaft bowing in the femur and tibia were related with BMD, the use of medication for osteoporosis might be a proper conservative approach to treatment.

Anterior and lateral bowing in the femoral and tibial shaft and multivariate factors.

Variables	Anterior femoral bowing	Lateral femoral bowing	Anterior tibial bowing	Lateral tibial bowing
Age	0.317 (p=0.022)	- 0.156 (p=0.271)	- 0.177 (p=0.210)	0.364 (p=0.008)
Body mass index	- 0.109 (p=0.442)	0.045 (p=0.750)	0.283 (p=0.042)	0.181 (p=0.200)
Lumbar spine BMD	- 0.160 (p=0.258)	- 0.252 (p=0.072)	0.039 (p=0.781)	- 0.206 (p=0.143)
Femoral neck BMD	- 0.345 (p=0.012)	- 0.076 (p=0.590)	0.117 (p=0.407)	- 0.293 (p=0.035)

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DOES ANKLE CARTILAGE ADAPT TO STRONG ALTERATIONS IN LOADING ENVIRONMENT AFTER TRANSPLANTATION TO THE KNEE (VAN NEES ROTATIONPLASTY)?

S. Maschek [1,2], F. Eckstein [1,2], W. Wirth [1,2], G. Gradl [3], C. Kirchhoff [3], K. Wörtler [3], R. von Eisenhart-Rothe [3]. [1] *Paracelsus Med. Univ., Salzburg, Austria;* [2] *Chondrometrics GmbH, Ainring, Germany;* [3] *Technical Univ., München, Germany*

Purpose: As for other tissues with mechanical function such as muscle or bone, it is widely assumed that the emergence and maintenance of articular cartilage is guided by functional adaptation to mechanical stimuli (e.g. Wolff's law). Here we study whether human ankle cartilage undergoes morphological changes following strong alterations in the loading environment (after being transplanted to the site of the human knee - van Nees rotationplasty type A1), and develops a cartilage thickness similar to that in the contra-lateral knee.

Methods: 12 participants (7 men, 5 women, age 17 to 61 years) were studied, in which the ankle of one limb had been transplanted to the site of the knee (rotationplasty type A1) between 8 and 18 years before this cross-sectional imaging study. Sagittal MR images (FLASH) of the transplanted ankle, contra-lateral ankle, and contra-lateral knee were obtained. Segmentation of the tibial and talar cartilage of the talocrural joint (TCJ), the talar and calcaneal cartilage of the subtalar joint (STJ), and the patella, trochlea, tibia, and weight-bearing femoral condyles of the knee joint (KJ) was performed using custom software (Chondrometrics GmbH, Ainring, Germany). The mean cartilage thickness (ThC.tAB) and size of the subchondral bone area (tAB) were computed in 3D using the same software. These were compared between transplanted and contra-lateral ankles, and with the knee (paired t-test with correction for comparisons of tests in 4 cartilage plates (required $p < 0.0125$ [$p<0.05/4$]).

Results: The mean cartilage thickness (ThC.tAB.Me) and subchondral bone areas (tABs) tended to be lower (rather than greater) in the transplanted than in the contra-lateral ankle (Table 1). The differences reached significance in the subtalar joint for the mean cartilage thickness, and in the talocrural talus and subtalar calcaneus for subchondral bone area. Values

Table 1
Cartilage thickness and area in the transplanted and contra-lateral ankle, and knee

Cartilage thickness (ThC.tAB; mm)		TP ankle	CL ankle	[CL knee]
TCJ tibia	[KJ tibia§]	1.01± 0.15	1.08± 0.14	[1.96± 0.36]*
TCJ talus	[KJ fem. condyle§]	1.00± 0.13	1.07± 0.15	[1.79± 0.28]*
STJ talus	[KJ patella]	0.96± 0.16	1.11± 0.19*	[2.30± 0.45]*
STJ calcaneus	[KJ fem. trochlea]	0.86± 0.13	0.97± 0.17*	[1.99± 0.24]*
Total subchondral bone area (tAB, cm^2)				
TCJ tibia	[KJ tibia#]	8.66± 1.35	9.06± 1.51	[22.0± 3.58]*
TCJ talus	[KJ fem. condyle#]	9.70± 1.70	11.33± 1.82*	[11.6± 1.69]*
STJ talus	[KJ patella]	5.57± 1.31	6.14± 1.24	[10.8± 1.63]*
STJ calcaneus	[KJ fem. trochlea]	4.92± 0.97	5.58± 1.06*	[22.0± 2.45]*

* significantly different from the TP ankle (paired t-test at $p<0.015$ [global sign. level = 0.05])
§ values from the medial and lateral sides averaged; # values added
TCJ = talocrural joint; STJ = subtalar joint; KJ = knee joint; fem = femoral; TP = transplanted; CL = contralateral

were significantly greater in the corresponding knee cartilage plates than in the transplanted talocrural and subtalar joint.
See Table 1: Mean cartilage thickness (ThC.tAB.Me) and subchondral bone area (tAB) in the transplanted (TP) talocrural joint (TCJ) and subtalar joint (STJ), in the contra-lateral (CL) TCJ and STJ, and in the CL knee joint (KJ).
Conclusions: The findings suggest that the cartilage thickness and subchondral bone area of the human ankle (talocrural and subtalar joints) do not adapt, with an increase in thickness or area, to changes in mechanical loading environment, when being transplanted to the site of the knee (van Nees rotationsplasty).

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KNEES WITH MEDIAL MENSICAL PATHOLOGY ARE MORE LIKELY TO UNDERGO TOTAL KNEE REPLACEMENT: A CROSS-SECTIONAL ANALYSIS FROM THE OSTEOARTHRITIS INITIATIVE

F.W. Roemer [1,2], C.K. Kwoh [3], D.J. Hunter [4], B. Boudreau [3], M.J. Hannon [3], M.D. Crema [1], F. Eckstein [5,6], M.R. John [7], Z. Wang [3], A. Guermazi [1]. for the OAI Investigators[1] *Boston Univ. Sch. of Med., Boston, MA, USA;* [2] *Klinikum Augsburg, Augsburg, Germany;* [3] *Univ. of Pittsburgh, Pittsburgh, PA, USA;* [4] *Univ. of Sydney, Sydney, Australia;* [5] *Paracelsus Univ. Salzburg, Salzburg, Austria;* [6] *Chondrometrics GmbH, Ainring, Germany;* [7] *Novartis, Basel, Switzerland*

Purpose: Total knee joint replacement (TKR) is a cost-effective procedure with good long-term outcomes. Optimized timing and clear indications for TKR are important to prevent unnecessary replacement of the original joint. However, at present there is no clear consensus on indications for TKR. Imaging biomarkers may be able to aid in the decision making process on a patient level as well as in clinical studies and trials.
Meniscal damage and extrusion are predictors of structural progression of osteoarthritis and thus, meniscal pathology may potentially serve as a candidate marker for TKR.
The aim of this study was to use a matched case-control design to determine if there are differences in presence and severity of meniscal damage and extrusion between cases that had knee replacement vs. matched controls that did not undergo TKR.
Methods: Participants were drawn from the Osteoarthritis Initiative (OAI), a multicenter observational study, including 4796 participants with, or at risk of knee osteoarthritis. We studied knees from 121 OAI participants that underwent TKR before the 48 month visit for the time point prior to TKR, i.e. "T0" (e.g. for a TKR reported at the 48 month (M) visit, T0 = 36M); and 121 control knees that did not undergo TKR that were matched for radiographic disease stage, gender, and age within 5 years and were assessed at the same T0 follow-up visit. MR images were acquired at four OAI clinical centers using dedicated Siemens Trio 3 T scanners. The coronal intermediate weighted (IW) 2D turbo spin-echo (TSE), the sagittal 3D dual echo at steady state (DESS) sequence, coronal and axial multiplanar reformations of the 3D DESS and a sagittal IW fat suppressed TSE sequence were used for semiquantitative assessment.
MRIs were read for medial and lateral meniscal morphology and extrusion using the semiquantitative MOAKS system, which scores meniscal morphology from 0 to 8 with 0 being normal and 8 coding complete meniscal maceration. Morphology was scored for the following locations: anterior horn, body, and posterior horn, for both the medial and lateral menisci. Grades 0 and 1 are considered the reference as a grade 1 depicts intrameniscal signal changes of unknown relevance. Grades 2-5 code different types of meniscal tears while grades 6-8 code different grades of meniscal maceration. Extrusion was graded from 0-3 at the medial and lateral joint lines on the coronal images.
Conditional logistic regression was used to assess the odds of TKR considering different measures of meniscal morphology.
Results: Subjects were on average 65.3 years old (SD ± 8.6), predominantly female (58.1%) and overweight (mean BMI 29.6 SD ± 4.9).
Table 1 demonstrates that knees that underwent TKR were more likely to have maceration of the medial meniscal body (unadjusted OR = 2.78 95% confidence interval [CI] [1.50,5.16]); to have maceration of the posterior horn (OR = 2.20 95% CI [1.07,4.53]); and to have a maximum meniscal scores of any maceration of the meniscus in any of the 3 locations of the medial compartment (OR = 2.96 95% CI [1.51,5.82]) when compared to matched non-TKR knees.
These associations were not observed for the lateral compartment or for meniscal extrusion.
Conclusions: Presence of maceration of the medial meniscal body and maceration of the medial posterior horn is more likely among TKR knees when compared to non-TKR knees. Further, risk for TKR is increased when a maximum grade of meniscal maceration is present in any of the analyzed medial meniscal locations. These data provide additional support to the importance of meniscal pathology in predicting important clinical outcomes.

Table 1. Comparison of meniscal damage and extrusion at T0 in TKR knees vs. matched non-TKR knees

MRI biomarker	N (%)	Odds of medial meniscal abnormality KR compared to no KR Odds Ratio (95% confidence intervals)	N (%)	Odds of lateral meniscal abnormality KR compared to no KR Odds Ratio (95% confidence intervals)
Anterior horn				
0/1	203 (83.9)	Reference	189 (78.4)	Reference
Max. 2-5 (tear)	6 (2.5)	5.00 (0.58,42.80)	13 (5.4)	0.89 (0.23,3.38)
Max 6-8 (maceration)	33 (13.6)	1.56 (0.68, 3.59)	39 (16.2)	1.36 (0.66,2.82)
Body				
0/1	117 (48.4)	Reference	181 (74.8)	Reference
2-5 (tear)	7 (2.9)	0.68 (0.12,3.76)	14 (5.8)	0.58 (0.19,1.73)
6-8 (maceration)	118 (48.8)	2.78 (1.50,5.16) *	47 (19.4)	1.29 (0.66, 2.54)
Posterior horn				
0/1	96 (39.7)	Reference	184 (76.4)	Reference
2-5 (tear)	56 (23.1)	1.05 (0.54,2.04)	18 (7.5)	1.68 (0.59,4.72)
6-8 (maceration)	90 (37.2)	2.20 (1.07,4.53) *	39 (16.2)	1.02 (0.50,2.05)
Maximum grade in any of 3 locations				
0 and 1	81 (33.5)	Reference	164 (67.8)	Reference
2-5 (tear)	33 (13.6)	1.47 (0.62,3.49)	18 (7.4)	0.84 (0.33,2.18)
6-8 (maceration)	128 (52.9)	2.96 (1.51,5.82) *	60 (24.8)	1.16 (0.64,2.11)
Meniscal extrusion				
No meniscal extrusion	48 (19.9)	Reference	184 (76.4)	Reference
Any mensical extrusion	193 (80.1)	1.54 (0.77,3.10)	57 (23.6)	1.15 (0.63,2.09)

* statistically significant at $p<0.05$